

**SYSTEM AND METHOD OF CONTROLLING APPLICATION LEVEL  
ACCESS OF A SUBSCRIBER TO A NETWORK**

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**CROSS REFERENCE TO RELATED APPLICATION**

This application is a Continuation-In-Part of U.S. Patent Application Serial Number 09/580,425, filed May 30, 2000, entitled "System and Method of Controlling Application Level Access of a Subscriber to a Network" which application is incorporated herein by reference in its entirety.

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Background of The Invention

5           The present invention relates to a system and method for controlling level or type of access of a subscriber to a network.

Description of the Prior Art

Access to a home network, through a visited network, has been limited to a single level of access. As a result, subscriber equipment has not been portable across multiple  
10   visited networks which are connected to a home network in view of their functionality being limited to a single level or type of access. In essence, each visited network through which a subscriber obtains access to a home network is limited to a single subscriber profile and does not provide for multiple subscriber profiles to facilitate different types of connectivity of a subscriber through a visited network to a home network.

15           Also seamless roaming, whether under the control of a home network or a visited network between different types of access networks, is an essential requirement in future mobile and fixed networks. While roaming between different types of access technologies, the entity providing voice over internet protocol/internet protocol (VoIP/IP) multimedia services may remain in the same network regardless of whether the network providing the  
20   multimedia services is a home or visited network. Examples of such entities VoIP/IP multimedia networks are, e.g. Call State Control function (CSCF), Gate Keeper, SIP Server.



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The networks directly connected to the home network in accordance with the invention are diverse in nature and without limitation may be a public cellular visited network such as a general packet radio system (GPRS), a wireline internet service provider (ISP), or a wireless local area network (LAN) such as, but without limitation, a local area network within a corporation. Regardless of the type of visited network directly connected to the home network, the application level registration message is sent from an entity in the visited network to an address of an entity in the home network which address is obtained from another network entity in the visited network. The entity in the home network receiving the application level registration message uses the received identification of the subscriber and the level or type of access to fetch from a storage in the home network a subscriber profile which is to be used to provide connectivity to the user equipment in the visited network and any network in accordance with the specified level or type of access in the application level registration message. The identification of the level or type of access contained in the application level of registration message is a pointer to the subscriber profile specifying the level or type of access and, upon fetching from the storage, is caused to be stored in a network entity either in the home network or in the visited network. The accessed subscriber profile is stored in the home network and accessed through a proxy entity in the visited network or is transmitted from the home network to the entity in the visited network from which the application level registration message was transmitted. Such entity is without limitation, a proxy server, gateway or serving call state control function (s-CSCF). The entity storing the subscriber profile in either the home network or the visited network functions to control the communications in accordance with well-known procedures for the subscriber user equipment in the visited network and the home network. If the visited network is a public cellular visited network, the entity receiving the subscriber profile for storage therein

may be a s-CSCF; and if the visited network is a wireline ISP or a wireless LAN, the entity in the visited network receiving the subscriber profile may be a proxy server utilizing the session initiation protocol (SIP) or a gatekeeper in accordance with the H.323 specification. The entity in the visited network which resolves the address in the home network to which  
5 the application level registration message is addressed may be a domain name server (DNS).

Different levels or types of access may be used to provide diverse types of connectivity. The access may be an application level access. For example, the diverse types of connectivity may provide a different degree of bandwidth in communications for  
10 each different access, a different degree of secured communications for each different access, or different supported supplemental services for each different access which supplemental services may be diverse in nature, such as diverse telephony services without limitation thereof.

The networks connected to the home network through a visiting network providing  
15 services to a subscriber may be access networks such as, without limitation, a GPRS, wireless local area network (WLAN) or a DSL network. The call control entity in the controlling network needs to know at the time of registration the type of access network at which subscriber registration occurs. An access type indicator provided to the call control entity provides the requisite identification of access network. The access type indicator may  
20 be provided to the home network directly or indirectly through a visited network from subscriber equipment, an interface between the subscriber equipment and the access network or by determination of a call control entity based upon characteristics of the access network such as, without limitation, packet characteristics.

The generation of the subscriber profile and the use thereof at the home network or at a control entity may be accomplished in many ways. Without limitation, the subscriber registration at an access network may be accomplished by transmitting an access type indicator directly to or through a visited network to the home network which identifies the type of access network at which registration has occurred. The source of the access type indicator may be explicitly provided by subscriber equipment or an interface between the subscriber equipment and the access network at which the subscriber is registered or implicitly from the control entity in a visited network analyzing the notice of the communications to form the access network to the control entity. Thereafter, the home network generates or accesses the subscriber profile which may have two parts which are a general service part and a part particular to the characteristics of the access type network to which the subscriber may roam.

A method of controlling access of a subscriber to a network in accordance with the invention includes sending an identification of the subscriber and an access to be provided to the subscriber from the visited network of a plurality of networks connected to the home network to the home network; in response to the identification of the subscriber and the access to be provided to the subscriber storing a subscriber profile of an authorized access to be provided to the subscriber; and controlling access of the subscriber to any network dependent upon a comparison of service to be provided to the subscriber and the stored subscriber profile. The access may be an application level of access. The storing of the subscriber profile may be in the home network or may be in the visited network. Each access may provide a different degree of bandwidth in communications; a different degree of security in communications for each different access; or a different supported supplementary services for each different access. The home network may be an internet

protocol network and the visited network may be a wireless public cellular bearer network.

The public cellular bearer network may be a general packet radio system network. The home network may be an internet protocol network and the visited network may be an internet service provider. The home network may be an internet protocol network and the

5 visited network may be a wireless local area network. The authorized access may be chosen from a plurality of authorized accesses which may be granted to the subscriber between the plurality of connected networks and the home network. An application level registration message containing the identification of the subscriber and the access may be generated in response to a request from subscriber equipment to a visited network entity; in  
10 response to an entity in the visited network receiving the request, an address of an entity in the home network may be obtained from a routing analysis in the visited network; and the application level registration message may be transmitted to the address in the home network. An entity of the home network may obtain the subscriber profile in response to receipt of the application level registration message.

15 A system in accordance with the invention includes a home network which stores a plurality of subscriber profiles each defining an access to be provided to a subscriber to a network; a plurality of networks connected to the home network; subscriber equipment connected to a visited network of the plurality of networks through which the subscriber obtains an access to any network; and wherein in response to connection of the subscriber  
20 equipment to the visited network, an identification of the subscriber and an access to be provided to the subscriber is sent to the home network, and a subscriber profile of an access to be provided to the subscriber is stored in one of the networks and access of the subscriber to any network is controlled by one of the networks storing the subscriber network dependent upon a comparison of the service to be provided to the subscriber and the stored

subscriber profile. A network entity within the home network or within the visited network may store the subscriber profile.

A method of controlling access of a subscriber to roam in networks in accordance with the invention includes providing an identification of the subscriber and an access of the  
5 subscriber at a home network, the access comprising an identification of access to one of the networks in which the subscriber is registered; in response to the providing of the identification of the subscriber and the access at the home network, storing a subscriber profile indicating an access to be provided to the subscriber to at least the networks; and using the stored subscriber profile in controlling service provided to the subscriber. The  
10 controlling of the service provided to the subscriber may occur while the subscriber is roaming in a visited network and the networks may be access networks from which the subscriber may obtain services while roaming in the visited network . The subscriber profile may be stored in the home network or in a visited network. The sending of the identification of the subscriber and an access may occur in response to the transmission of an access  
15 type indicator identifying a network in which the subscriber is registered through the visited network to the home network. The subscriber profile may comprise general service data used in providing service to the subscriber and data regarding permitted access of the subscriber to the networks. The access may originate from equipment of the subscriber registered in one of the networks. The access may originate from a network entity providing  
20 an interface between the visited network and one of the access networks to which the subscriber is registered. The access may be determined by a call control entity based upon information obtained by the control entity about the network to which the subscriber is registered. In response to at least one subsequent identification of the subscriber and the access being provided at the home network, the home network may send to the visited

network an acknowledgment of a change in registration of the subscriber to another access network. The access may be used by the home network to control connectivity of communications to the subscriber through the home network.

5 A method of controlling access of a subscriber to register in networks in accordance with the invention includes providing an identification of the subscriber at a home network; in response to the providing of the identification of the subscriber, storing a subscriber profile of an access to be provided to the subscriber to at least the networks; and using the stored subscriber profile in controlling service provided to the subscriber. The controlling of the service provided to the subscriber may occur while the subscriber is registered in a visited  
10 network and the networks may be access networks from which the subscriber may obtain services while registered in the visited network. The storing of the subscriber profile may be in the home network or in the visited network. The providing of the identification of the subscriber may occur in response to transmission of an access type indicator to the home network identifying an access network in which the subscriber is registered. The access  
15 may originate from equipment of the subscriber registered to one of the networks. The access may originate from a network entity providing an interface between the visited network and one of the access networks to which the subscriber is registered. The access may be determined by a call control entity based upon information obtained by the control entity about the network to which the subscriber is registered.

20 A system in accordance with the invention includes a home network which stores a plurality of subscriber profiles each defining an application level of access to be provided to a subscriber while registered in networks; networks in which the subscriber may register; at least one subscriber equipment which is connected to the networks while the subscriber is registered therein; and wherein in response to connection of the subscriber equipment to

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one of the networks at least an identification of the subscriber is provided at the home network, a subscriber profile of an authorized access to be provided to the subscriber to at least the networks is stored, and the stored subscriber profile is used in controlling service provided to the subscriber. The controlling of the service provided to the subscriber may occur while the subscriber is registered in a visited network and the networks may be access networks from which the subscriber may obtain services while roaming in the visited network. A storage in a visited network may store the subscriber profile. An access comprising an identification of access to one of the networks in which the subscriber is registered may be transmitted from the visited network to the home network and the storing of the subscriber profile may be in response to the identification of access at the home network. The stored subscriber profile may be used by the visited network in controlling service provided to the subscriber.

#### Brief Description of The Drawings

Fig. 1 illustrates a first embodiment of a plurality of networks connected to a home network in accordance with the present invention.

Fig. 2 illustrates a first embodiment of connectivity of a subscriber through subscriber equipment from a public cellular visited network to a home network in accordance with Fig. 1 assuming call control is at the visited network.

Fig. 3 illustrates a second embodiment of connectivity of a subscriber through subscriber equipment from a public cellular visited network to a home network in accordance with Fig. 1 assuming call control is at the home network.

Fig. 4 illustrates connectivity of a subscriber through subscriber equipment through a wireline ISP to a home network in accordance with the present invention.

Fig. 5 illustrates connectivity of a subscriber through subscriber equipment through a wireless LAN to a home network in accordance with the present invention.

Fig. 6 illustrates a second embodiment of a plurality of networks connected to a home network through a visited network in accordance with the present invention.

5 Fig. 7 illustrates a first methodology of generation and transferring of subscriber profile information with the embodiment of Fig. 6.

Fig. 8 illustrates a second methodology of generation and transferring of subscriber profile information with the embodiment of Fig. 6.

10 Fig. 9 illustrates a third methodology of generation and transferring of subscriber profile information with the embodiment of Fig. 6.

Like parts are identically identified throughout the drawings.

#### Description of the Preferred Embodiments

Fig. 1 illustrates a first embodiment 9 of a plurality of networks directly connected to a home network 10. The plurality of connected networks which, without limitation, may be as  
15 illustrated in Fig. 1 a public cellular visited network 12 such as GPRS, a wireline ISP 14 and a corporation wireless LAN 16. As illustrated, the connectivity of the particular subscriber equipment 18 is identified as "Case 1", "Case 2" and "Case 3" respectively between the public cellular visited network 12, wireline ISP 14 or corporation wireless LAN 16 and the home network 10. In each of the three cases, an application level registration message is  
20 sent from an entity, such as s-CSCF 22 or Proxy Server/Gatekeeper 24, in a visited one the plurality of networks 12, 14 and 16 connected to a home subscriber server (HSS) 20 or user mobility server (UMS) which contains the subscriber identification and the different profile for different access modes to be provided to the subscriber. The application level registration

message contains an identification of the subscriber such as, but not limited to, the IMSI of the subscriber equipment 18 and the level or type of access which is encoded as a multiple bit access mode identification and is transmitted from the network entity 22 or 24 in the visited network to the HSS 20 in the home network 10. In the public cellular visited network 12, the entity transmitting the application level registration message is a s-CSCF 22 which is well known; in the wireline ISP the entity transmitting the application level registration message is a proxy server/gatekeeper 24 which are well known with the proxy server using the SIP protocol or the gatekeeper being in accordance with the H.323 specification; and in the corporate wireless LAN 16, the network entity is also a proxy server/gatekeeper 24.

Case 1 operation is explained from an overview standpoint as follows. The subscriber utilizes subscriber equipment 18 to transmit message "1" to the s-CSCF 22 to request an application level registration through the public cellular visited network 12 to the home network 10. The s-CSCF 22 transmits message "2" to a DNS 26 which resolves the address of the HSS 20 to which the application level registration message is to be sent from the s-CSCF 22. The address is returned from the DNS 26 to the s-CSCF 22 as message "3". Thereafter the s-CSCF 22 transmits message "4" to the HSS 20 which contains the subscriber identification and an identification of the application level of connectivity which is sought. The HSS 20 retrieves from a storage 28 a subscriber profile of an authorized type or level of access associated with the subscriber identified in the message received by the HSS 20. The storage 28 may be any home network entity and may be part of the HSS 20. The storage 28 stores for each of the connected networks 12, 14 and 16 or any other network, including networks other than the networks illustrated in Fig. 1 to which the subscriber may be connected to obtain telecommunications services, one



for each different access mode or different connection of supplementary services for each different access. For example, the use of different bandwidths for connectivity between the subscriber equipment and the visited network or the home network may be dependent upon an authorized expense of communications available to the subscriber, the functionality of the subscriber equipment or network conditions. For example, the different degrees of access for security purposes may be dependent upon the subscriber, the network or the subscriber equipment. As a result of the diversity of the types or levels of access which may be requested by or allocated to the subscriber, it is possible to provide different types of connection services to the subscriber when connecting different types of subscriber equipment 18 through different networks 12, 14 and 16 or any other connected network including networks not illustrated in Fig. 1.

Figs. 2 and 3 illustrate detailed call flows for first and second embodiments of a public cellular visited network functioning as the visited network connected to the home network 10. The distinction between Figs. 2 and 3 is that in Fig. 3 the s-CSCF, which controls the communications, resides in the home network with a p (proxy) -CSCF residing in the visited network 12 which functions as an intermediate entity in the providing of connectivity for the communications between the storage of the subscriber profiles of the levels or types of access in the s-CSCF of the home network and the visited network. In essence the p-CSCF acts as a proxy call state control function in the visited network with the actual call state control function being exercised by the s-CSCF in the home network 10.

With reference to Fig. 2, the transport level registration procedure and the signalling packet data protocol (PDP) context establishment are generally in accordance with the prior art procedures for public cellular networks such as GPRS and therefore are only described briefly.



the stored subscriber profile in order to control access of the subscriber to the network which may either be granted or denied depending upon whether the comparison yields that the level or type of access does not exceed the stored level or type of access contained in the subscriber profile. As illustrated, step "6" shows the authorization of the subscriber

5 equipment in order to have connectivity which is identified in step 6 by "200 ok" which is a standard SIP designation for a granted authorization.

Fig. 3, as discussed above, is analogous to Fig. 2 except that the s-CSCF is resident in the home network 10 and a p-CSCF is resident in the visited network through which the communications involving the application level registration message are routed between the

10 UE and the HSS 20 of the home network 10. As a result of the p-CSCF being resident in the visited network 12, additional messages "[SIP]CSCF assignment" identified as "5" and "[SIP]CSCF Assignment Ack" identified as "6" are required but otherwise the communications are identical to Fig. 2. Messages 5 and 6 are used by the HSS 20 to assign a s-CSCF in the home network and download the subscriber profile to the s-CSCF.

15 Fig. 4 illustrates the sequence of communications for the wireline ISP 14 with the transport level registration process, which is well known, having been established. The communications "1"- "6" are in accordance with Fig. 1 except that the deregistration process between the HSS and an old SGSN and an old one of a s-CSCF/Proxy Server/Gatekeeper are illustrated involving previous application level registration messages. The

20 communications "1"- "6" are analogous to the communications of Figs. 2 and 3 with the exception that the proxy server is the entity in the wireline ISP 14 through which the application level registration message communications are routed and further which stores the fetched subscriber profile.

Fig. 5 illustrates the sequence of communications between the corporate wireless LAN 16 and the home network 10. The transport level registration process, which is well known, is established. The communications "1"-"6" are in accordance with Fig. 1 except that the deregistration process between the HSS and an old SGSN and an old one of a s-CSCF/Proxy Server/Gatekeeper are illustrated involving previous application level registration messages.

Fig. 6 illustrates a second embodiment 100 of a plurality of networks connected through a visited network 102 to a home network 104. The plurality of networks may be access type networks which, without limitation, may be as illustrated a GPRS network 106, a wireless local area network (WLAN) 108, or a DSL network 110. The embodiment 100 is different than the embodiment 9 of Fig. 1 in that subscriber equipment 112 is registered in the access networks 106, 108 and 110 by connection through the visited network 102 to the home network 104 which performs the same functions generally as the home network 10 of Fig. 1. The subscriber's roaming between registration in the access networks 106, 108 and 110 is indicated by dotted line 114. In the embodiment 100, the subscriber equipment 112 generates a transport level registration message which is known and an application level registration message 116 which is communicated to the CSCF entity 118 of visited network 102. The application level registration message 116 provides at least an identification of the subscriber and in two embodiments as discussed below, a level or type of access which is transmitted to the CSCF entity 118 and then to an HSS or UMS entity 120 of home network 104. The CSCF 118 transmits a message, e.g. a SIP register message 122 to the HSS or UMS 120 of the home network 104. The update location message 122 informs the HSS or UMS 120 of the subscriber equipment identification and particular access network 106, 108 or 110 at which the subscriber equipment 112 is

registered so as to permit the home network 104 to route communications through the visited network 102 to the particular access network 106, 108 or 110 in which the subscriber is registered. In addition to the updating of the location of the subscriber equipment 112 in two embodiments described below, an access type indicator (ATI) is transmitted from the

5 CSCF entity 118 to the HSS or UMS 120 which identifies the type of access network at which the subscriber is registered. The content of the ATI permits the HSS or UMS to control connectivity through the visited network 102 for communications which are to terminate in one of the access networks 106, 108 and 110, such as, for example, based upon a subscriber profile stored in storage 123, which is analogous to the relationship

10 between the HSS 20 and the storage 28 of the home network 10 of the embodiment 9 of Fig. 1. The HSS or UMS 120 transmits, at least in response to the first registration message from one of the access type networks 106, 108 and 110, a subscriber profile to be used by the CSCF entity 118 in controlling of connectivity communications to the subscriber equipment 112. The subscriber profile may be all subscriber data, which is not organized

15 into any specific access network specific information, that is conveyed to the CSCF entity 118 or, alternatively, the subscriber profile may be general service data which pertains to aspects of the subscriber which are not particular to the access type networks 106, 108 and 110 and access specific information which pertains to service aspects of the subscriber which are particular to the access specific networks in which the subscriber equipment 112

20 roams. The general subscriber information and the access specific information are referred to as "a master profile" hereinbelow.

Upon registration of the subscriber with one of the access networks 106, 108 and 110, it is necessary to inform at least the CSCF entity 118 and in two embodiments





in the procedures 140 and 150. The difference is that, as a consequence of the HSS or UMS 120 not knowing the ATI, the home network 104 cannot perform any call termination functions which can result in the overall network being less efficient in that a communication which is not suited for termination at the subscriber device 112 in a particular access type  
5 network will be transmitted to the visited network 102 where the CSCF entity 118 performs the function of denying termination of the communication in the appropriate circumstance either because the subscriber's profile does not permit such a termination to occur or even if the subscriber profile does permit the termination to occur, the functionality of the access type network at the time that the communication is sought to be terminated does not permit  
10 the termination to occur.

If the CSCF entity 118 determines the ATI implicitly instead of with an explicit message as described above in the procedures 140, 150 and 160, the same processes are performed thereafter after the ATI indicating the type of access network at which the subscriber equipment 112 is registered is implicitly determined.

15 The embodiment of Figs. 6-9 permits adaption of the network which includes a home network 102 and a visited network 104 to provide an available set of services to access type networks 106-110 in which a subscriber is registered. This permits such functions as call screening at the access network at which the subscriber terminal 112 is registered to be performed to deny connection thereto based upon any number of factors which may include  
20 quality of service (QoS).

In addition to when access network changes occur, at which time the HSS sends the subscriber information to the CSCF, the subscriber information may be requested at other times from the HSS by the CSCF.

While the invention has been described in terms of its preferred embodiments, it should be understood that numerous modifications may be made thereto without departing from the spirit and scope of the appended claims. It is intended that all such modifications fall within the scope of the appended claims.

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